SOLAPUR UNIVERSITY, SOLAPUR

M.Sc. Part-I GENETICS

Revised Syllabus (New CBCS Pattern Syllabus)
w. e. f. June 2016

SOLAPUR UNIVERSITY, SOLAPUR

M. SC. GENETICS

REVISED SYLLABUS (NEW CBCS PATTERN)
(w. e. f. June, 2016)

1) Title of the Course: M. Sc. GENETICS

2) **Introduction:** This course will provide the knowledge of genetics to understand genetics information of plants, animals and microorganisms also. It will discuss the basic concepts of genetics and focus how to identify genetic disorders by karyotyping analysis and inheritance related to normal and abnormal genes. Students will learn Mendelian genetics as well as advance genetics. This knowledge of genetics helps them for genetic counseling.

3) Objectives of the course:

- To equip the students with the requisite background in areas of modern biology (biochemistry, cell biology, genetics, Biostatistics, bioinformatics and molecular biology)
- Become knowledgeable about the genetic inheritance and disease related karyotyping.
- To launch the students into core areas of Genetics like Mendelian genetics, advance genetics, Gene mapping, genetic disorders, study of animal and plant genome, Mutation study etc.
- To explore the students to applied areas of genetics like production of new plant variety by gene mutation, sequencing, karyotyping, genetics counseling etc.
- To provide practical experience to students by giving them an opportunity to pursue project work in an identified area of Genetics.
- Students should gain substantial competency in content, skills, and awareness within the field of Genetics.

4) Advantages of the course:

- Students will learn through applying the strategies and tools used in genetics to aware people about genetic disorders by proper counseling.
- A number of recent workforce studies have shown that there is a high current and unmet demand for people trained to various levels of expertise in genetics.
- The emergence of new plant breeding technologies, gene mapping, DNA sequence analysis, Phylogenetic analysis in closely related as well as endangered species, Karyotyping analysis has enabled genetics to address the biological problems from several different angles. It is this change in paradigm that has led to the development of genetics as a separate skill oriented discipline.
- This course provides scope for employment opportunities in various industries in the applied aspects Biotechnology, Microbiology, Molecular biology, various research institution and academics.

5) Eligibility of the Course

Candidates who have passed (a) 10+2 with Science and (b) Bachelor's degree in Science / Technology/ Agriculture / Medicine / Veterinary Science / Pharmaceutics from recognized University and as per the eligibility criteria lay down by Solapur University; Solapur will be eligible for admission to M.Sc. course in Genetics.

6) Duration: The course will be of two years' duration and shall be completed in four semesters.

7) Medium of instruction: English

8) Structure of the Course:

- Structure of M.Sc. course in faculty of Science has total of 4 semesters for 2 years.
- M. Sc. I comprise of total two semesters and M. Sc. II comprises of total two semesters.
- Semester I include four theory papers (3 Hard Core and 1 Soft Core) and practical course as per theory papers.
- Semester II & III includes four theory papers (2 Hard Core, 1 Soft Core and 1 Open Elective) and practical course as per theory papers.
- Semester IV includes four theory papers (3 Hard Core and 1 Soft Core) and a Major project substituting the practical course.
- Each theory paper comprising of 5 units which are distributed in total 60 Lecture hours having weightage of 4 credits.
- Practical papers are to be conducted at the end of their respective semester.
- Final year Major project work should begin in III semester and the complete thesis should be submitted at the end of the IV semester.
- Student would have to present his/her project work during the project report submission which would be evaluated by the internal as well as the external examiner.
- As per the credit system, the assessment of Theory paper of 100 marks weightage will be as: 70 marks theory assessment by University examination (UA) and 30 marks internal assessment by the college (CA). For internal assessment of candidate, periodical tests/seminars/ viva/oral / quiz etc. may be suitably adopted.
- As per the credit system, the assessment of practical paper of 100 marks weightage will be as: 70 marks theory assessment by University examination (UA) and 30 marks internal assessment by the college (CA).
- In each semester student has to compulsorily give a total number of 16 tutorials (4 tutorials per theory paper) which has weightage of 25 marks.

SOLAPUR UNIVERSITY, SOLAPUR
Syllabus for M.Sc. Genetics Part - I
(w. e. f. June, 2016)

COURSE STRUCTURE

SEMESTER I

M. Sc. I- GENETICS CBCS w. e. f. 2016-17 (REVISED) SEMESTER-I									
SEM -I	**Code**	**Title of the Paper**	**Semester Exam.**			**L**	**T**	**P**	**Credits**
		Hard Core	UA	IA	Total				
GEN	HCT 1.1	Concepts of Genetics	70	30	100	4	----	----	4
	HCT 1.2	Biostatistics and Population genetics	70	30	100	4	----	----	4
	HCT 1.3	Cytogenetics and Genome Organization	70	30	100	4	----	----	4
Soft Core (Any one)									
	SCT 1.1	Cellular and Molecular Biology	70	30	100	4	---	----	4
	SCT 1.2	Clinical Bioinformatics	7 0	30	100	4	---	----	
		Tutorial			25		1		1
Practicals									
	HCP 1.1	**Practical Course HCP 1.1**	35	15	50	----	---	2	6
	HCP 1.2	**Practical Course HCP 1.2**	35	15	50	----	---	2	
	HCP 1.3	**Practical Course HCP 1.3**	35	15	50	----	---	2	
Soft Core (Any one)									
	SCP 1.1	**Practical Course SCP 1.1**	35	15	50	----	---	2	2
	SCP 1.2	**Practical Course SCP 1.2**	35	15	50	----	---	2	
Total for First Semester			**420**	**180**	**625**	----	---		**25**

SOLAPUR UNIVERSITY, SOLAPUR
Syllabus for M.Sc. Genetics Part - I
(w. e. f. June, 2016)

COURSE STRUCTURE
SEMESTER-II

M. Sc. I- GENETICS CBCS w. e. f. 2016-17 (REVISED) SEMESTER-II									
SEM-II	**Code**	**Title of the Paper**	**Semester Exam.**			**L**	**T**	**P**	**Credits**
GEN		**Hard Core**	UA	IA	Total				
	HCT 2.1	Regulation of gene Expression and developmental genetics	70	30	100	4	---	---	4
	HCT 2.2	Concepts of Biochemistry	70	30	100	4	---	---	4
Soft Core (Any one)									
	SCT 2.1	Advanced microbial genetics	70	30	100	4	---	---	4
	SCT 2.2	Industrial and Environmental Biotechnology	70	30	100	4	---	---	
Open Elective(Anyone)									
	OET 2.1	Plant breeding and Tissue culture	7 0	30	100	4	---	---	4
	OET 2.2	Computational Structure Biology and Drug designing	7 0	30	100	4	---	---	
		Tutorial			25	---	1	---	1
Practicals									
	HCP 2.1	**Practical Course HCP 2.1**	35	15	50	---	---	2	4
	HCP 2.2	**Practical Course HCP 2.2**	35	15	50	---	---	2	
Soft Core(Any one)									
	SCP 2.1	**Practical Course SCP 2.1**	35	15	50	---	---	2	2
	SCP 2.2	**Practical Course SCP 2.2**	35	15	50	---	---	2	
Open Elective(Anyone)									
	OEP 2.1	**Practical Course OEP 2.1**	35	15	50	---	---	2	2
	OEP 2.2	**Practical Course OEP 2.2**	35	15	50	---	---	2	
Total for Second Semester			**420**	**180**	**625**	**---**	**---**	**---**	**25**

** **L = Lecture T = Tutorials P = Practical**

** **IA=Internal Assessment**

** **UA= University Assessment**

** **4 Credits of Theory = 4 Hours of teaching per week**

** **2 Credits of Practical = 4 hours per week**

** **HCT = Hard core theory**

** **SCT = Soft core t**

** **HCP = Hard core practical**

** **SCP = Soft core practical**

** **OET = Open elective theory**

** **OEP = Open elective practical**

** **MP = Major project**

M. SC. GENETICS (SEMESTER –I)

HCT 1.1: CONCEPTS OF GENETICS **4 Credit - (60 L)**

UNIT I: **[13]**

Introduction: Cell Division – Mitosis and Meiosis. Model systems in genetic analysis: General Outline of genome of *E.coli, Neurosporacrassa*, maize, Drosophila, Life cycle of *S.cerevisiae, C.elegans, Arabidopsis thaliana, Homo Sapiens.*

UNIT II: **[12]**

Laws of Inheritance: Mendel's Law of Dominanace, segregation, and Independent assortment. Test cross, Back cross, Co-dominanace, Incomplete dominance, Allelic Interaction, multiple allele Linkage: Concept, Recombination, Crossing Over, Gene mapping in Prokaryotes and Eukaryotes, Complementation test.

UNIT III: **[12]**

Structure of Sex Chromosomes, Sex linked Inheritance: Complete and incompletely sex linked genes. Inheritance of XY linked genes, Y linked genes, X linked genes, Sex limited and Sex influence gene. Quantitative inheritance: Concept, Genes and Environment: heritability, Penetrance and expressivity.

UNIT IV: **[12]**

Mutation: Types - Spontaneous and Induced Mutations, Chemical and Physical Mutagenic agents, Mechanism of action of Mutagenic agents, Transposon mediated mutagenesis. Changes in Chromosome number and Structure: Polyploidy, Aneuploidy, Chromosomal aberrations – Intra and Inter chromosomal aberrations.

UNIT V: **[11]**

DNA Damage and Repair: Base excision repair (BER), Nucleotide excision repair (NER), Mismatch repair (MMR), Homologous recombination (HR), Non homologous end joining (NHEJ), Photo reactivation and Dark repair.

Recommended Text Books:

1. Concepts of Genetics- Klug W. S. And Cummings M. R Prentice-Hall
2. Genetics-a Conceptual Approach Pierce B. A. Freeman
3. Genetics- Analysis of Genes and Genomes Hartle D. L. And Jones E. W. Jones & Bartlett
4. An Introduction to Genetic Analysis- Griffith A. F. et al Freeman
5. Principles of Genetics -Snustad D. P. And Simmons M. J. John Wiley & Sons.
6. Genetics- Strickberger M. W. Prentice-Hall
7. Genetics - B.D.Singh
8. Genetics - Verma&Agrawal
9. Genetics - P.K.Gupta

HCT 1.2 BIOSTATISTICS AND POPULATION GENETICS **4 Credit - (60 L)**

UNIT I: **[15]**

Basic terms, measures of central tendency and dispersion: Population, Sample, sampling method, variable, parameter, classification of data, Frequency distribution, tabulation, graphic and diagrammatic representation. Mean, median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis, Probability and distributions: Definition of probability (frequency approach), independent events. conditional probability, Examples of Bernoulli, Binomial, Poisson and Normal distributions. Coefficient of distribution, Use of these distributions to describe in biological models.

UNIT II: **[10]**

Bivariate data: Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination**.** Hypothesis Testing: Hypothesis, critical region, and error probabilities. Z-test,'t'-test, Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to analysis of variance.

UNIT III: **[10]**

Introduction: Overview of history and evolutionary theories with more emphasis on synthetic theory of evolution, Mendelian and Biometrician controversy, Population Genetics and Birth of Neo-Darwinism, Genetics polymorphism, Hardy-Weinberg genetic Equilibrium with example, Forces affecting the Hardy-Weinberg Genetic equilibrium. Causes of changes in allele frequency through natural selection/artificial selection.

UNIT IV: **[15]**

Heritability and measurement of variability. Genetic load – overview and causes. Co-adapted gene complex – Traits controlled by two loci, three loci and multi-loci. Isolating mechanisms: Classification – (a) Geographic isolation (b) Reproductive isolation – (i) Premating isolation – Climatic, Seasonal, Habitat, Ethological (ii) Post mating isolation – gametic mortality, zygotic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown (c) Origin of reproduction isolation – Muller's view, Dobzhansky view. Speciation: (a) Species types (b) Species categories (c) Concepts of species (d) Models of speciation (e) Hybridization and speciation (f) Phyletic gradualism and punctuated equilibrium (g) Molecular aspect of speciation -speciation genes.

UNIT V: **[10]**

QTL mapping strategies; Statistical methods for mapping QTL in experimental cross populations (experimental design, linkage map construction, single-marker analysis, interval mapping and multiple interval mapping), Estimation of breeding values and genetic variances in general pedigrees, association mapping, genomic selection, direct and associative models of general group and kin selection, genotype by environment interaction models.

Recommended Text Books:

1. DNA markers Protocols, applications and overviews- Anolles G. C. &Gresshoff P. Wiley-Liss
2. Molecular markers in Plant Genetics and Biotechnology -Vienne De. D. Science Publishers
3. Genetics of Population- Hedrick P.W. Jones & Bartlett
4. Principle of Population Genetics -Hartl D. L. and Clark A.G Sinauer Associates
5. Biostatistics- Danial, W. W Wiley
6. Statistical methods in Biology- Bailey, N.T.J Cambridge Univ.Press

7. Statistical Genetics: Linkage, Mapping and QTL analysis, Ben Hui Liu – CRC Press
8. Statistical Genetics: Gene Mapping Through Linkage and Association, ed. By B Neale, M Ferreira, S Medland, D Posthuma – Taylor Francis
9. The Fundamentals of Modern Statistical Genetics NM Lairdand, C Lange - Springer
10. Computational Molecular Evolution, Z Yang, 2006, Oxford University Press.

HCT 1.3 CYTOGENETICS AND GENOME ORGANIZATION **4 Credit - (60 L)**

UNIT I: **[14]**

Chromosome structure, Organization: Chromatin structure, Nucleosomal and Higher order, Telomere and its maintenance. Mitotic and Meiotic Chromosomes. Heterochromatin and euchromatin, Special types of chromosomes – Polytene chromosome, Lamp-brush chromosome. B chromosome, Sex chromosome.

UNIT II: **[10]**

Chromosome Banding – (G, Q, C, R) and Painting, Karyotyping, *In-situ* hybridization (FISH and GISH), Somatic cell hybridization, Somaclonal Variation

UNIT III: **[12]**

Extra Nuclear inheritance - Maternal inheritance, Mitochondrial, and Chloroplast, P-element in *Drosophilla*. Plasmids: Types, detection, replication, incompatibility, partitioning, copy number control and transfer. Properties of some known plasmids.

UNIT IV: **[12]**

Genome organization in viruses, bacteria, animals and plants. Mechanisms of sex determination in plants, animals and *Drosophila* (Dosage compensation), Organization of nuclear and organellar genomes.

UNIT V: **[12]**

Genome mapping (Physical maps) and functional genomics; Repetitive DNA-satellite (minisatellite, microsatellite DNA). Introduction to Transposable Elements in Prokaryotes and Eukaryotes, C-value paradox, LINES, SINES, Alu family, Fine structure of gene, multigene families.

Recommended Text Books:

1. Essential Cell Biology -Alberts B. et al. Garland
2. Molecular Biology of The Cell- Alberts B et al. Garland
3. The Eukaryotic Chromosome- TBostock C. J. & Summer A. T.T Elsevier
4. The Chromosome- Hamsew and Flavell Bios
5. Advanced Genetic Analysis- Hawley & Walker Blackwell
6. Structure & Function of Eukaryotic Chromosomes- Hennig Springer
7. Genes IX- Lewin B. Pearson
8. Molecular Cell Biology -Lodish, H. et al. Freeman
9. Cell and Molecular Biology- De Robertis& De Robertis Lippincott & Wilkins
10. Genome 3 -Brown T. A. Garland

SCT 1.1 CELLULAR AND MOLECULAR BIOLOGY **4 Credit - (60 L)**

UNIT I: **[14]**

Types of replication, DNA replication in prokaryotes and eukaryotes - i) Initiation of replication process: Origin of replication in Prokaryotes and Eukaryotes, ii) Elongation: coordinated synthesis of Leading and Lagging strands. iii) Termination: End of replication. Transcription Mechanism-Initiation, Elongation and Termination in Prokaryotes and Eukaryotes, RNA Polymerase.

UNIT II: **[12]**

Genetic code- deciphering the code, codon usage, Eukaryotic and Prokaryotic Translation. Membrane Trafficking: Vesicular transport from Endoplasmic reticulum to Golgi Apparatus, Endoplasmic reticulum and its function, Vesicular transport in Golgi apparatus. Golgi Complex and its function

UNIT III: **[07]**

Antisense, RNAi, Micro RNA - Mechanism and Examples, Ribozyme Tailor made for gene silencing.

UNIT IV: **[15]**

Cytoplasmic Membrane: Chemical Composition of Membrane, Structure and function of Membrane proteins, Fluid Mosaic Model, Movement of substances across cell membrane – Diffusion, Active transport. Cell Cycle and Cell-Cell Adhesion: Cell Cycle Phases, Extracellular space, Desmosomes, Hemidesmosomes, Integrins, Selectins, Cadherins, Tight Junction, Gap Junction.

UNIT V: **[12]**

Signal Transduction: G protein coupled receptor, tyrosine Kinase receptor - Ras- MAP Kinase pathway, Hedgehog pathway, WNT signalling pathway, Notch Pathway, Nf-κB Pathway.

Recommended Text Books:

1. Molecular Biology of the Gene- Watson, J. et al. Benjamin Cummings
2. Molecular Cell Biology -Lodish,H. et al. W. H. Freeman
3. The World of the Cell- Becker, W.M. et al. Benjamin Cummings
4. Essential Cell Biology- Alberts B. et al. Garland
5. Molecular Biology of The Cell -Alberts B et al. Garland
6. Cell & Molecular Biology by Karp
7. Genetics by B.D.Singh
8. Genetics by Verma&Agrawal
9. Genetics by P.K.Gupta
10. Cell and Molecular Biology by P.K.Gupta

SCT 1.2 CLINICAL BIOINFORMATICS **4 Credit - (60 L)**

UNIT I: **[13]**

Next Generation Sequencing; Introduction, Process, Application, NGS Platforms & Techniques, NGS Tools: Data & Data Formats, introduction to R scripting and QC tools PrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOT, NGS Methods: Reference Based Genome Assembly, De Novo Genome Assembly, Transcriptomics, Epigenomics, Genome Mapping, Microarray Data Analysis, RNA Sequence Analysis and NGS Data Annotation.

UNIT II: **[13]**

Medical Bioinformatics: Basic understanding, causes and available treatment strategies for bacterial and viral and parasitic diseases, Neurodegenerative disorders, Disease of circulatory system and respiratory system, Cancer, Genetic diseases. Introduction to pathology informatics, study of pathogen genomes (bacteria, fungi and viruses), databases, computational study of host–pathogen interactions (Animals and Plants).

UNIT III: **[10]**

Clinical Data Analysis: Introduction to Medical coding, International Classification of Disease-10, Pharmacoviglance, Tools for Clinical trial data analysis and management.

UNIT IV: **[12]**

System and Functional Biology: Pharmacogenomic: Introduction, History, Application and Challenges. System Biology, System structures, system dynamics Metabolomics: Introduction to Metabolome, Metabolites, Metabonomics, Analytical technologies, applications.

UNIT V: **[12]**

Genome sequencing projects and applications: human Genome Project Introduction, Applications, Challenges of HGP, Introduction to various genome sequencing projects and their implications in human health and diseases, Comparative genome analysis Genome data visualization using Ensemble and Mapviewer.

Recommended Text Books:

1. EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss, Garry Wong 2014: RNA-seq Data Analysis: A Practical Approach by Chapman & Hall/CRC Mathematical and Computational Biology
2. Robert Gentleman: 2008 R Programming for Bioinformatics by Chapman and Hall/CRC
3. Shui Qing Ye 2015: Big Data Analysis for Bioinformatics and Biomedical Discoveries by Chapman and Hall/CRC
4. Bentley DR, Balasubramanian S, Swerdlow HP, et al. Accurate whole human genome sequencing using reversible terminator chemistry. Nature. 2008; 456:53-59

PRACTICALS

Practical Course HCP 1.1Concepts of Genetics 2 Credit

1. Study of mitosis
2. Study of meiosis.
3. To Study the effect of mutagens on germination, seedling growth and on mitosis.
4. Mendelism problem: one factor & two factor with examples.
5. Problems on non-Mendelian genetics.
6. Problem on gene mapping.
7. Problems on Linkage.
8. Study of adaptation in *Drosophila* by biotic/abiotic effect.
9. Spontaneous mutation: Fluctuation test – StrR.
10. Spontaneous mutation: Replica plate method-StrR

Practical Course HCP 1.2 Biostatistics and Population genetics 2 Credit

1. Study of data presentation-graphical.
2. Study of data presentation-diagrammatic.
3. Study of measures of central tendency.
4. Study of measures of dispersion.
5. Study of correlation and regression.
6. Study of probability.
7. Examples on student 't' test.
8. Examples based on pedigree analysis.
9. Examples based on Hardy Weinberg Equilibrium.

Practical Course HCP 1.3 Cytogenetics, Genome organization 2 Credit

1. Preparation of *Drosophila*/*Chironomas*polytene Chromosomes
2. *Drosophila* genetic crosses.
3. Study of different morphology of nucleus.
4. Chromosome preparation from human blood lymphocytes.
5. Identification of inactivated X chromosome as Barr body.
6. G-banding and karyotyping.
7. DNA isolation from plants.
8. Problems on extrachromosal inheritance.
9. Quantitative analysis of DNA using DPA method.
10. Qualitative analysis of DNA - Physical Property (Tm Melting Temperature).

Practical Course SCP 1.1 Cellular and Molecular Biology **2 Credit**

1. Isolation and estimation of RNA from Bacteria.
2. Quantization of DNA by spectrophotometer.
3. Size fractionation of total DNA using electrophoresis.
4. Ligation of DNA using electrophoresis.
5. Isolation of Mitochondria.
6. Isolation of Chloroplast.
7. Isolation of organellar DNA.
8. Isolation of total Protein from Baker's Yeast (Translation).
9. Estimation of total Protein from Baker's Yeast (Translation).

Practical Course SCP 1.2 Clinical Bioinformatics **2 Credit**

1. Practical's based on R language.
2. Study online Next Generation sequencing resources and databases.
3. Study of PrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOTtools.
4. Study of Microarray Data Analysis tools and databases.
5. Introduction of International Classification of Disease-10 codes.
6. Study of Human genome project database and genome analysis tools

M. SC. GENETICS (SEMESTER –II)

HCT 2.1 REGULATION OF GENE EXPRESSION AND DEVELOPMENTAL GENETICS

4 Credit (60 L)

UNIT I: [13]

Gene regulation in prokaryotes: Operon model of regulation (with examples of *lac*, *trp* and *ara*). Negative, positive and attenuation control in bacteria. Control of lysis and lysogeny in Lambda phage. Gene regulation in eukaryotes: Overview of gene regulation using examples of galactose-utilization in yeast; heat shock gene expression; Signal integration in Human β- Interferon gene.

UNIT II: [13]

Transcriptional control – changes in chromatin structure, epigenetics controls, Post transcriptional regulation – alternative RNA splicing, RNA editing, RNA stability, Translational regulation – RNA structure, control at initiation, codon usage, Post Translational modification.Regulation of SV40 and CaMV 35S viral promoters. Hormonal control of gene regulation in animals (thyroxine and insulin) and plants (cytokinin& gibberellins). Regulation of Cell cycle.

UNIT III: [13]

Basic concepts in development: Potency, commitment, specification, induction, competence, determination and differentiation; Production of gametes, cell surface molecules in spermegg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryo sac development and double fertilization in plants; embryogenesis, establishment of symmetry in plants; seed formation and germination.

UNIT IV: [13]

Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans;* eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

UNIT V: [08]

Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in*Arabidopsis* and *Antirrhinum.*

Recommended Text Books:

1. Genes and Signals- Mark Ptashne and Alexander Gann CSHL Press
2. A Genetic Switch- Mark Ptashne CSHL Press
3. Gene Regulation- David S Latchman Chapman & Hall
4. Genes- Benjamin Lewin Prentice Hall
5. Molecular Cell Biology- Lodish, H. et al. W. H. Freeman
6. Principles of Developmental Genetics, -Sally A. Moody Academic Press
7. Advances in Anatomy, Embryology and Cell Biology, -Korf, H.-W., Beck, F., Clascá, F., Haines, D.E., Hirokawa, N., Putz, R., Timmermans, J.-P. Springer
8. Developmental Biology- Gilbert S. F. Sinauer
9. Development of *Drosophila melanogaster* (Vol I & II)- Bates and Arias CSHL Press
10. Developmental Biology, 1992 3rd edition, Browder L.W. Erickson C.A. &Williams, R.J. Saunders College, Publications, London.
11. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London

HCT 2.2 CONCEPTS OF BIOCHEMISTRY **4 Credit (60 L)**

UNIT I: **[10]**

Laws of Thermodynamics: Concept of Free Energy, Standard free energy change and chemical equilibrium, Biological oxidation reduction reaction, Redox potential, ATP as energy-rich compound.

UNIT II: **[15]**

Protein - classification according to its function. Amino Acids, Classification of amino acids. Peptides, The primary, secondary and tertiary and quaternary structure of proteins. Ramachandran Plot. Enzymes as biocatalysts; enzyme classification, Properties of enzymes, Active site. Mechanism of enzyme action, Michaelis-Menten Equation, inhibition of enzymes.

UNIT III: **[07]**

Vitamins - Classification, Structure and biological role of - Thiamin, Riboflavin, Nicotinic acid, Biotin, Folic acid , Ascorbic Acid, Vitamin A, D ,E, K.

UNIT IV: **[13]**

Carbohydrate - Classification, structure, general properties and functions, Glycolysis, Gluconeogenesis, Cori Cycle, TCA, HMP Shunt, Glycogen metabolism, Oxidative phosphorylation, Structure of ATPase. Photosynthesis: Structure of Chloroplast, Light and Dark Reaction, Photophosphorylation, Calvin Cycle, HSK Pathway, CAM Pathway.

UNIT V: **[15]**

Lipids - Classification, structure, properties and functions of fatty acids; Storage lipids Phospholipids, sphingolipids, steroids, Biosynthesis of fatty acids, Beta oxidation of fatty acid, Reactions of amino acid metabolism – transamination, deamination, decarboxylation, Urea Cycle, Nucleotides, Purines and Pyrimidines, Nucleotide Biosynthesis – Salvage and De NOVO.

Recommended Text Books:

1. Principles of Biochemistry -Lehninger et al. Freeman
2. Biochemistry -Devlin, T.M. Wiley-Liss
3. Biochemical Calculation -Sehgal I. H. Wiley
4. 4 Fundamentals of Enzymology -TPrice N. C. and Lewis S.T Oxford University Press
5. Biochemistry -TBerg, J. M. Tymoczko, J. L and Stryer L.T W. H. Freeman

SCT 2.1 ADVANCED MICROBIAL GENETICS **4 Credit (60 L)**

UNIT I: **[10]**

Conjugation: Discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F, map of F plasmid, mechanism of chromosome transfer in bacteria.

UNIT II: **[12]**

Transformation: Natural transformation systems, Biology and mechanism of transformation, Competency, regulation of competency in *B. subtilis*, Artificial induced competency- calcium ion induction and electroporation.

UNIT III: **[12]**

Transduction: Generalized and specialized or restricted transduction, Phage P1 and P22- mediated transduction, mechanism of generalized transduction, abortive transduction. Temperate phage lambda and mechanism of specialized transduction.

UNIT IV: **[15]**

Techniques for studying bacteriophages: Virulent phage (TB4B) and Temperate phage (phagelambda). Important aspects of lytic cycle, phage-host relationships, immunity and repression. Bacterial mutagenesis: Mutation, evidence of spontaneous nature of mutation, Fluctuation test, Methods of isolation of autotrophic mutants, drug resistant mutants and phage resistant mutants, analysis of mutation in biochemical pathways.

UNIT V: **[11]**

Overview of Fungal Biology: Fungal life cycle and various phases, Fungi in nature, fungi in biotechnology, and as experimental tools. Yeast Mating - Type Switching mechanism,

Recommended Text Books:

1. Microbial Genetics -Maloy S., Cronan J., Freifelder D Jones and Bertlett
2. Fundamental Bacterial Genetics- Trun N and Trempy J Blackwell Publ.
3. Modern Microbial Genetics- Streips U. N. and Yasbin R E.Wiley-Liss
4. Molecular Genetics of Bacteria- Sneider L. and Champness W. ASM Publishers
5. Genetics of Bacteria- Scaife J. Academic Press
6. Genetics of Bacteria and Viruses- Birge E. A. Springer
7. Molecular Genetics of Bacteria- Dale J.W. and Park S Wiley
8. Fungal Genetics: Principles and Practice Bos C J. CRC
9. The Mycota Ed. Esser K. &. Lemke P. A. Springer
10. Essential Fungal Genetics-Moore D.& Frazer N. Springer
11. Fungal Genetics- Fincham Springer

SCT 2.2 INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY 4 Credit (60 L)

UNIT I: [15]

Introduction to bioprocess engineering, bioreactors, isolation, preservation and maintenance of industrial microorganisms, microbial growth kinetics, media formulation for industrial fermentation, Air and media sterilization. Designing of a fermenter/bioreactor. Types of fermentation process batch, fed batch and continuous, biotransformation, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.) Measurement and control of bioprocess parameters.

UNIT II: [12]

Upstream Process: Industrial production of chemicals: alcohols, acids (citric, acetic and gluconic), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid), single cell proteins, single cell oil, dairy products, wine, beer and other alcoholic Beverages.

UNIT III: [09]

Downstream process: introduction, removal of microbial cells and solid matters, foam separation, filtration, centrifugation, cell disruption, precipitation, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment.

UNIT IV: [12]

Scope of Biotechnology- in Environmental protection. Nonconventional energy sources. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics.UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Ecoplanning and Sustainable Development

UNIT V: [12]

Bioremediation-Biotechnology for clean environment, Biomaterials as substitutes for non-degradable materials, Metal microbe interactions: Heavy Metal Pollution and impact on environment, Microbial Systems for Heavy Metal Accumulation, Biosorption, molecular mechanisms of heavy metal tolerance. Bioindicators and biosensors for detection of pollution, Hazardous Waste Management, Xenobiotics, Biological Detoxification of PAH, Air Pollution Control, Solid Waste Management.

Recommended Text Books:

1. Sullia S. B &Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Glaser A.N &Nilaido. H (1995) Microbial Biotechnology,W.H Freeman & Co.
3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers& Distributors.
4. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. &Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology.,Aditya Books (P) Ltd. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House
7. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology
8. Dash : Concepts of Ecology
9. Chattergy : Environmental Biotechnology
10. Varma&Agarwal : Environmental Biology
11. B.K. Sharma : Environmental Chemistry
12. Peavy&Rowe : Environmental Pollution
13. Asthana&Asthana : Environment Problems & Solutions

OET 2.1 PLANT BREEDING AND TISSUE CULTURE **4 Credit (60 L)**

UNIT I: **[10]**

History; Genetic resources- centers of diversity and origin of crop plants, Law of Homologous variation, genetic resources. Breeding methods for self-pollinated, crosspollinated and clonally propagated crops. Component, recombinational and transgressive breeding. Single seed descent. Populations, their improvement methods and maintenance, Hybrid breeding and genetic basis of heterosis.Ideotype breeding.Mutation breeding.

UNIT II: **[15]**

Plant Breeding for Stress Resistance and Nutitional Quality: Genetic basis and breeding for resistance to diseases and insect-pests. Breeding for vertical and horizontal resistance to diseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistance to heat, frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits. Role of molecular markers in stress resistance breeding: MAS, MARS and MABB.

UNIT III: **[15]**

Plant regeneration pathways - Organogenesis and Somatic embryogenesis; Endosperm culture and triploid production; Anther and pollen culture, and production of haploid and doubled haploid plants; Protoplast culture and fusion, Somatic hybrids; Organelle transfer andcybrids; Micropropagation,artificial seed and bioreactor technology, Virus-free plants by meristem culture; Use of somaclonal and gametoclonal variation for crop improvement; In vitro mutagenesis and mutant selection; Preservation of plant germ plasm*in-vitro*.

UNIT IV: **[10]**

Cryopreservation -Principle and types. Biosynthesis- batch, continuous cultures, immobilized plant cell, Biotransformation of precursors by cell culturing, metabolic engineering for production of secondary metabolites, Hairy root culture, elicitation.

UNIT V: **[10]**

Transgenic crops for resistance against biotic and abiotic stresses; Transgenic plants-Edible vaccine, Golden rice; Engineering crops for male sterility and modification of flower colour, flowering, fruit ripening and senescence; GM crops for nutritional quality and quantity; RNAi-mediated crop improvement; Molecular pharming; Other applications; Global status and biosafety of transgenic plants.

Recommended Text Books:

1. Principles of Plant Breeding, Allard RW – Wiley
2. Plant Breeding Theory and Practice, Stoskopf NC, Tomes DT and Christie BR – Westview Press
3. Quantitative Genetics, Genomics and Plant Breeding, Kang MS – CABI Publishing
4. Plant Molecular Breeding, Newbury HJ – CRC Press
5. Plant Cells in liquid culture (1991), Payne Shuler Hanser Publishers.
6. Introduction to plant tissue culture- M.K. Razdan
7. Plant tissue culture-Theory & practice-S.S.Bhojwani& M.K. Razdan
8. Plant tissue culture-KalyankumarDey
9. Biotechnology- H.S. Chawla

OET 2.2 COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGNING

4 Credit (60 L)

UNIT I: **[15]**

Introduction to Structural and Pathway Databases: structural data, exploring the structural databases such as Protein Data Bank (PDB) at RCSB, Catalytic Site Atlas (CSA), Homology Derived Structures of Proteins (HSSP), Protein Data Bank Europe (PDBe), PDBeChem, PDBeFold, PDBeMotiff, PDBeNMR, PDBSum, SCOP and CATH. Introduction to biological Pathway Databases.

UNIT II: **[10]**

Structure Prediction Methods: Statistical methods of Chou-Fasman, Garnier- Osguthorpe- Robson method, Neural network method, Position specific scoring matrices, Motifs and domains, folds and protein folding.

UNIT III: **[10]**

Homology Modeling: Introduction to homology modeling, Fold recognition and Threading, RNA structure prediction, architectures and topologies of protein and DNA using molecular visualization software, Structure validation.

UNIT IV: **[10]**

Molecular interaction: Molecular interaction; protein-protein, protein-DNA, Protein- Lipid, Protein-Ligand, Protein-Carbohydrate, DNA-Drug interaction, Metalloproteins, Pi … Pi interactions, C-H…Pi interactions.

UNIT V: **[15]**

Drug Discovery and Drug designing: Natural products, drugs, principles of drug development, Drug discovery, mutation in drug targets, automated drug design, structure based and ligand based drug design methods, combinatorial chemistry, high throughput screening (HTS), *in silico*ADMET properties, QSAR, developing lead library, DOCKING; introduction to docking method to generate new structure, tools and molecular docking programs-AUTODOCK, HEX and VLifeMD suite, virtual screening, Drug metabolism; Cytochrome p450, pharmacodynamics and pharmacokinetics, clinical trials, FDA approval.

Recommended Text Books:

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997
2. Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
3. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.Second Edition, Wiley.
4. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution.SinauerAss.,USA.
5. Essential Bioinformatics, Jin Xiong
6. Rastogi S. C., Mendiratta. N., Rastogi. P. 2005 Bioinformatics methods and application, Genomics, Proteomics, and Drug Discovery.

PRACTICALS

Practical Course HCP 2.1 Regulation of gene expression and developmental genetics

2 Credit

1. Induction and assay of β- galactosidase from *E.coli*.
2. Observation of homeotic mutants of *Drosophila*
3. Study of Chick embryo development (preparation of whole mounts & permanent slides)
4. Study of different types of sperms by smear technique- Frog, Hen, Rat and Human
5. Study of Cleavage, Blastula and Gastrula –Frog and Hen (Slide/ICT)
6. Study Teratogenic effect on development of Frog / Chick embryo
7. Study of developmental phases in human (By ICT)
8. To study types of ovules and male gametophytes (by permanent slides)
9. Study of floral patterning in any suitable flower
10. Quantitative estimation of Protein by Biurete method.

Practical Course HCP 2.2 Concepts of Biochemistry **2 Credit**

1. Quantitative estimation of Protein by Lowry's method.
2. Quantitative estimation of Glucose by DNSA method.
3. Quantitative estimation of Total sugar by anthrone method.
4. Quantitative estimation of Cholesterol from serum by Zacs method.
5. Determination of acid value, Iodine number, and saponification of fat/oil.
6. Isolation of casein from milk.
7. Isolation of starch from potato.
8. Immobilization of enzyme (Calcium chloride and Sodium alginate).
9. Assay of amylase by iodometric method.
10. Qualitative analysis of Carbohydrate/lipid/amino acids.

Practical Course SCP 2.1 Advanced microbial genetics **2 Credit**

1. Isolation of Rhizobium from root nodule.
2. Seed dressing and inoculation with *Rhizobia.*
3. Perform experiment to study bacterial transduction.
4. Perform experiment to study bacterial Conjugation
5. Perform experiment to study bacterial Transformation
6. Detection and estimation of protease inhibitors from pulse seeds.
7. Isolation of vitamin B12 auxotrophic mutants.
8. Isolation and quantification of genomic DNA from bacteria.
9. Isolation of Plasmid DNA from bacteria.

Practical Course SCP 2.2 Industrial and Environmental Biotechnology **2 Credit**

1. Fermentative production of Organic solvents: - Ethanol/Acetone/ Butanol.
2. Alcoholic beverages: Beer/ Wine
3. Fermentative production of Amino Acid: L-glutamic acid/Phenylalanine/ L-lysine & Vitamins: Vitamin B12.
4. To study the BOD & COD levels of different water systems.
5. Bacteriological analysis of water by presumptive, confirmatory and completed tests
6. Isolation of xenobiotic degrading microorganisms

Practical Course OEP 2.1 Plant breeding and Tissue culture **2 Credit**

1. Induction of polyploidy using colchicines. (Root Tip)
2. Cytological analysis of polyploidy plants. (Root Tip)
3. Study of Pollen fertility.
4. Isolation of genomic DNA from Plants.
5. Isolation of Ti Plasmid from Agrobacterium.
6. Media preparation, sterilization and callus culture.
7. Somatic embryogenesis and somaclonal variation, micro-propagation.
8. Cell suspension culture.
9. Isolation of protoplast by chemical and mechanical methods.
10. Synthetic seeds preparation.
11. Visit to commercial R & D green houses, agro based industries.

Practical Course OEP 2.2 Computational Structure Biology and Drug designing

2 Credit

1. Accessing to Structural Databases and Data retrieval using RCSB PDB, CSA, PDBe, PDBeChem, PDBeFold, PDBeMotif and PdbSum.
2. Structural classification using CATH, SCOP resources.
3. Secondary structure prediction using SOPMA and GOR.
4. Homology modeling by SWISSMODEL, and Modeller 9V2 and
5. Model Validation using RAMPAGE or PROCHECK,
6. Prediction of protein-protein, protein-DNA, protein-ligand interactions and Drugbank and Chembank databases and Design of ligands using ACD lab and Chemsketch
7. Development of lead library and high throughput screening using *in silico*ADMET Properties.
8. Docking studies using AUTODOCK and HEX.